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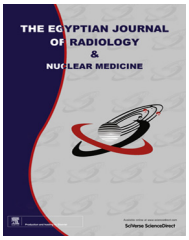

ORIGINAL ARTICLE

Assessment of breast lesions using BI-RADS US lexicon in mammographically dense breasts (ACR categories 3 and 4) with histopathological correlation

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KEYWORDS

Mammographically dense breasts BI-RADS US lexicon

Abstract *Purpose:* To assess the role of ultrasonography in detection, and categorization of breast lesions in patients with mammographically dense breasts with the use of the BI-RADS US lexicon.

Patients and methods: This study included 60 female patients (age range from 20 to 80 years, mean 38.3 ± 11.9) complaining of mastalgia, breast lump or nipple discharge with mammographically dense breast tissue. Breast ultrasound was performed to all patients with a 12-MHz linear-array transducer. Sonographic findings of the breast lesions were described and categorized according to the BI-RADS US assessment categories. Biopsy procedures were performed for the sonographically detected breast lesions with histopathological examination of the biopsied tissue.

Results: The main complaint was palpable breast mass encountered in 25 patients, 12 of mastalgia, 4 of nipple discharge, 12 patients were on screening and 7 on follow up. 36 patients were categorized as ACR 3 and 24 ACR 4 regarding the density of their breasts in mammography. Mammography revealed no abnormalities in 31 patients and abnormal in 29 patients, the commonest mammographic finding was breast mass, detected in 19 patients. Ultrasound detected breast lesions in 56 (93.3%) out of 60 patients. BI-RADS US category 2 was the most common category representing 36.7%. Ultrasonography had a diagnostic reliability for differentiating between benign and

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malignant breast lesions ($p = 0.869$) in mammographically dense breasts while mammography was diagnostically unreliable ($p = 0.045$).
Conclusion: Ultrasound is a mandatory adjunct to mammography in detection and characterization of breast lesions in mammographically dense breasts.

1. Introduction

Mammographically dense breast tissue has been defined by the American college of radiology (ACR) Breast Imaging Reporting and Data System (BI-RADS). Dense breast has been categorized into four progressively more dense patterns; (1) almost entirely fat (dense area is 1–25% of total breast area); (2) scattered fibroglandular densities (dense area is 25–49% of total breast area); (3) heterogeneously dense (dense area is 50–74% of total breast area) that may lower the sensitivity of mammography; (4) extremely dense (dense area is >75% of total breast area) which could obscure a lesion. In general, dense breasts are considered ACR categories 3 and 4 (1).

Imaging of mammographically dense breasts represents a diagnostic challenge for interpreting radiologists (2). Dense fibroglandular tissue is the most important inherent limitation of mammography in the diagnosis of breast cancer, especially non calcified breast cancer. Furthermore, dense breast tissue is a reported risk factor in the subsequent development of breast cancer, particularly in women with a first-degree family history of this malignancy (3,4).

The sensitivity of mammography in the diagnosis of breast cancer is variable and influenced by age, breast density, family history, and other factors (5). One of the most important factors leading to false-negative findings on mammography is the effect of breast density (3).

Current advances in ultrasound technology and scan head design permit greater spatial and contrast resolution and shortened scan time. Dense glandular tissue usually has a hyper-echoic appearance on sonography. Because most breast cancers are hypoechogenic, carcinomas in this setting are easily detected on sonography (6).

The aim of this study was to assess the role of ultrasonography in detection, description and categorization of breast lesions in patients with mammographically dense breasts based on the BI-RADS US lexicon.

2. Patients and methods

2.1. Patients

This study was approved by the ethics committee of our institution during the period between January 2012 and March 2013. It included 60 female patients referred from the surgery and oncology clinics. They were either complaining (mastalgia, breast mass or nipple discharge), or on screening or follow up. All the patients included in this study had mammographically dense breast parenchymal pattern (ACR 3 and ACR4).

2.1.1. Ultrasonographic examination

Superficial gray scale ultrasonographic examination of the breast was performed to all the patients using GE, Logic 5 pro ultrasound real-time unit with a 12-MHz linear-array transducer. Both breasts were systematically examined with overlapping scans in a radial and anti-radial pattern from the nipple to the periphery. The retro-areolar region was separately scanned with angled views to ensure the complete coverage of all breast tissue. The detected breast lesions were localized by the clock face method and were categorized as normal, probably benign, benign, suspicious for malignancy or malignant based on BI-RADS US assessment categories (7). The US lexicon includes six morphologic features of solid breast masses: shape, orientation, margin, lesion boundary, internal echo pattern, and posterior acoustic features according to BI-RADS US descriptors (7).

2.1.2. Biopsy

Biopsy procedures were performed for breast lesions that were detected by US in 56 (93.3%) out of 60 patients. The Biopsy procedures were as follows; fine needle aspiration biopsy for 39 patients, core needle biopsy for 3 patients, and surgical biopsy for 14 patients.

2.1.3. Pathological examination

Histo-pathological examination of the biopsied specimen of each breast lesion was performed to act as a gold standard reference for our results.

2.1.4. Statistical analysis

Data entry was done by SPSS version 17 and analyzed by the same software. Frequency distribution, descriptive statistics, and correlation analysis were done using Chi^2 and Fisher exact tests for qualitative data and student's t test for quantitative data. The probability (p value) of less than 0.05 is used as a cut off point for all significant tests.

3. Results

This study had included sixty female patients. Their ages ranged from 20 to 80 years with a mean value of 38.3 ± 11.9. Forty-one patients were complaining, 12 patients were on screening and 7 were on follow up. The most common patient complaint was palpable breast mass encountered in 25 patients followed by mastalgia in 12 patients and nipple discharge in 4 patients. The patients were chosen according to the American college of radiology (ACR) Breast Imaging Reporting and Data System (BI-RADS) classification of their mammographic

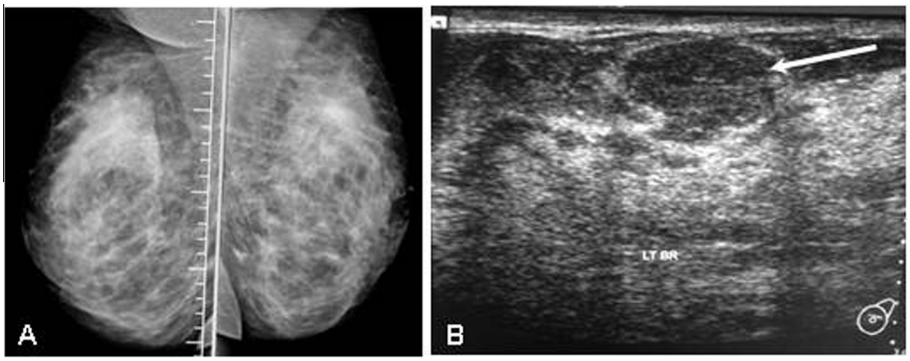

Fig. 1 32-y old female presented with mastalgia and palpable left breast mass. (A) Mammographic images (medio-lateral oblique (MLO)) revealed breast density of ACR 4, with no definite underlying lesions. (B) Ultrasonographic image of left breast shows a mass (*arrow*) at 10 o'clock, oval in shape, horizontally oriented with well circumscribed sharp margins and hypo-echoic texture. Such features are consistent with benign looking nodule of fibroadenoma, categorized as BI-RADS 2. This lesion confirmed by histopathological examination to be fibroadenoma which was done upon the patient's will.

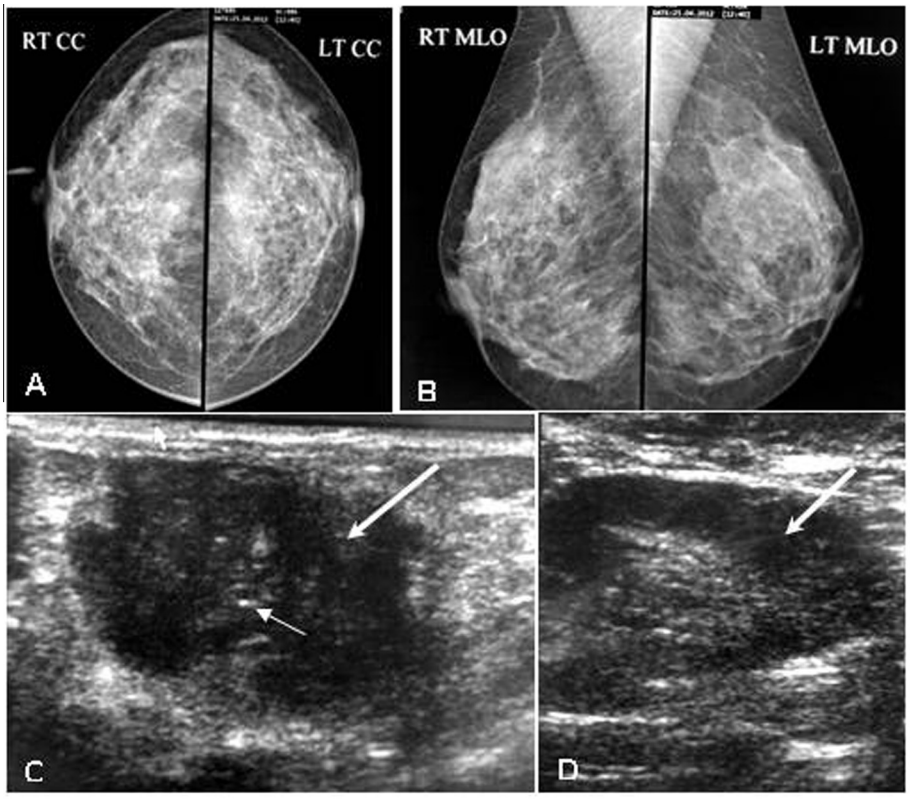

Fig. 2 29-y old female presented with palpable left breast mass. (A) & (B) Mammographic images (cranio-caudal (CC) & (MLO)) revealed breast density of ACR 4. No underlying lesions. (C) Ultrasonographic image of the left breast revealed a mass at 2 o'clock which is irregular in shape, taller than wider, with micro-lobulated margin and surrounded by echogenic rim. It has hypoechoic texture with dots of calcifications; this mass assessed as malignant mass: BI-RADS 5. (D) Ultrasonographic image of the left axilla shows enlarged lymph nodes with thickened cortex and bit medulla, features consistent with malignant lymph nodes. Histopathological examination of the breast lesion disclosed invasive ductal carcinoma.

images. Those who were included were ACR categories 3 and 4 (mammographically dense breast) Table 1. The mammograms of all the 60 patients were interpreted for the presence or absence of abnormal mammographic findings. The mammograms reveal no abnormalities in 31 (51.7%) out of 60 patients. The most commonly detected mammographic finding was suspected breast mass, it was demonstrated in 19 (31.7%) out of 60 patients Table 2.

Breast US detects breast lesions in 56 (93.3%) out of 60 patients and shows no abnormalities in 4 (6.7%) out of 60 patients. According to the analysis of the BI-RADS US descriptors, the breast lesions were classified into 6 categories

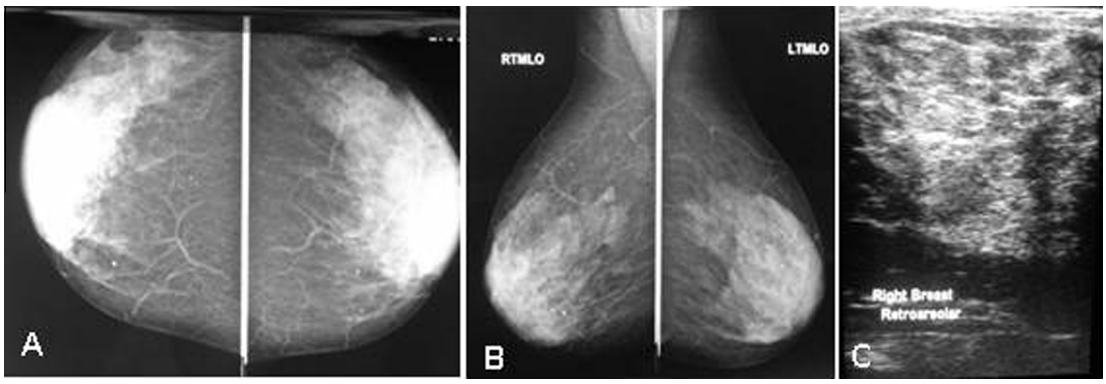

Fig. 3 44-y old female presented with mastalgia of the right breast. (A) & (B) Mammographic images (CC & MLO) revealed breast density of ACR 3 with bilateral retro-areolar fullness. (C) Ultrasonographic image of the right breast excluded any underlying hidden solid or cystic lesions, categorized as BI-RADS 1.

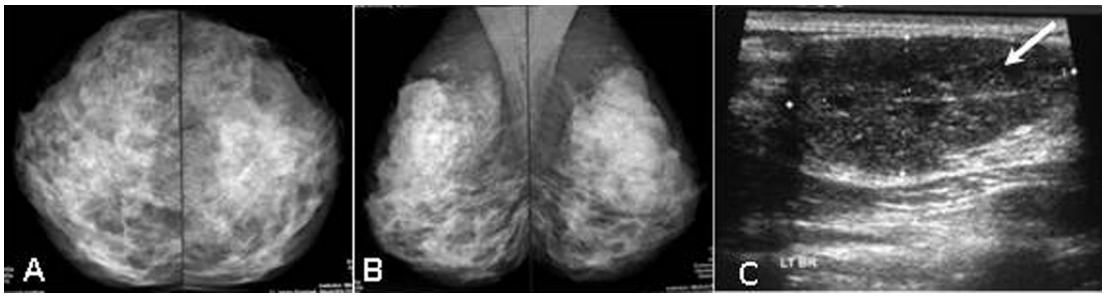

Fig. 4 39-y old female presented with left breast mass. (A) & (B) Mammographic images (CC & MLO) showed breast density of ACR 4. No definite underlying lesions. (C) Ultrasonographic image of the left breast showed a mass at the retro-areolar region. It has macrolobulated borders and an inhomogeneous echopattern with cystic spaces and posterior acoustic enhancement, phylloides tumor is suggested categorized as BI-RADS 4. This diagnosis was confirmed by the histopathological examination.

Table 1 ACR categories of the mammographically dense breasts (categories 3 & 4) of the studied group.

ACR BI-RADS	NO.	Percent (%)
Category 3	36	60
Category 4	24	40
Total	60	100

Table 2 Mammographic findings in the studied group.

Mammographic findings	No.	Percent (%)
No abnormalities	31	51.7
Abnormal findings	29	48.3
Mass	19	31.7
LN	2	3.3
Asymmetric density	3	5
Calcification	7	11.7
Total	60	100

(from 0 to 6). BI-RADS US category 2 was the most common category in this study representing 36.7% (Table 3, Figs. 1–4)

Histo-pathological examination of the biopsied specimen of each breast lesion was performed for 56 patients. The most common benign breast lesion was fibroadenoma, it was detected in 16 (26.7%) out of 60 patients and the most common malignant breast lesion was invasive ductal carcinoma, it was detected in 8 patients (13.3%) out of 60 patients Table 4.

Table 3 BI-RADS US assessment categories of the breast lesions.

BI-RADS US Category	No.	Percent (%)
0	0	0
1	4	6.7
2	22	36.7
3	8	13.3
4	10	16.7
5	16	26.7
6	0	0

Correlation between the ultrasonographic and mammographic results with the pathological results for diagnosing breast lesions was performed. The diagnostic category (Benign, indeterminate and malignant) of ultrasonography and mammography was statistically tested for their reliability for diagnosing and for differentiating between benign and malignant breast lesions using the pathological diagnosis as a gold standard. In this study ultrasonography had a diagnostic reliability for diagnosing and for differentiating between benign and malignant breast lesions ($p = 0.869$) in mammographically dense breasts while mammography was diagnostically

Table 4 The pathological types of the breast lesions.

Pathological type	No.	Percent (%)
Fibroadenoma	16	26.7
Fibrocystic changes	9	15
Benign cyst	7	11.7
Phylloides tumor	3	5
Invasive duct carcinoma	8	13.3
Ductal carcinoma in situ	5	8.3
Invasive lobular carcinoma	5	8.3
Inflammatory carcinoma	3	5

Table 5 Correlation between mammography and pathological results.

Assessment on mammography	Pathological verification			*p* Value
	Benign	Malignant	Total	
Misdiagnosed	22	18	40	0.045
Diagnosed	8	4	12	
Indeterminate	2	2	4	
Total	30	24	56	

Table 6 Correlation between ultrasonographic and pathological results.

Assessment on sonography	Pathological verification			*p* Value
	Benign	Malignant	Total	
Misdiagnosed	3	1	4	0.869
Diagnosed	22	22	44	
Indeterminate	7	1	8	
Total	32	24	56	

unreliable for detecting and diagnosing breast lesions ($p = 0.045$) Tables 5 and 6.

A comparison between ultrasonographic and mammographic diagnostic reliability for the detection of breast lesions in mammographically dense breasts revealed that the ultrasound is far superior to the mammography in detection and characterization of breast lesions, this was statistically significant ($p = 0.035$) Table 7.

4. Discussion

Mammographic density is a strong risk factor for breast cancer and that risk of breast cancer is 4–6 times greater in women with density more than 75% compared with those with less or no density (8–11).

In a population with elevated risk and extremely dense breast tissue (12), mammography sensitivity was only 40–50%. Breast ultrasonography is considered as an effective second-line screening test in the evaluation of women with dense breast tissue on mammography. The American College of Radiology (ACR) established the first edition of the Breast Imaging Reporting and Data System (BI-RADS) lexicon for US in an attempt to standardize image interpretation and reporting and to improve communication among radiologists, referring physicians, and surgeons (13).

In this study, the patient ages ranged from twenty to eighty years with a mean value of 38.3 ± 11.9. This mean age was younger than the mean age that was previously described by Checka (14) who reported that the median age of the breast cancer screening patients was 57 years and Disha (15) who mentioned that the mean age of women with breast symptoms was 56 years. This can be explained by that all the patients involved in our study had mammographically dense breasts, and dense tissue has generally been associated with younger age and premenopausal status and as the age advances, the dense breast tissue gradually decreases. Checka (14) clarifies the relationship of mammographic density and age; he reported that there was a significant inverse relationship between age and mammographic breast density ($p < 0.001$). This also was proved histologically by Milanese (16).

The commonest patient complaint was palpable breast mass as it was encountered in 25 (41.7%) out of 60 patients, this coincided with Klein (17) who reported that palpable breast mass is a common complaint and is usually benign. One study examined 40 to 69 year old women presenting with breast complaints – 40% of these were for breast lumps. In those complaining of a lump, breast cancer was found in only 11% of patients.

The patients included in this study were categorized according to ACR BI-RADS lexicon for mammography. Those who were included were ACR categories 3 and 4 (mammographically dense breast). ACR category 3 was the most commonly encountered category representing 60% of the patients. The mammograms reveal no abnormalities in 31 (51.7%) out of 60 patients, while the others gave us incomplete data of the lesions detected. This was in accordance with Jackson (18) who addressed the limitation of mammography in detection of breast lesions in dense breasts, he reported that the sensitivity of mammography for detecting cancer is lower in dense breasts, Pinsky (19) also postulated that the possibility of a cancer being masked by overlying breast tissue is greater in dense breasts than fatty ones. Kolb (20) clarified that extremely dense breasts having tissue that can obscure cancer in >75% of the breast.

BI-RADS US lexicon is still less widely used than is the BI-RADS lexicon for mammography because it is still in its early editions (7). According to the analysis of the BI-RADS

Table 7 Comparison between ultrasonography and mammography reliability for diagnosis of breast lesions in dense breasts.

Sonography	Mammography				*p* Value
	Misdiagnosed	Diagnosed	Indeterminate	Total	
Misdiagnosed	2	2	0	4	0.035
Diagnosed	40	7	1	48	
Indeterminate	2	3	3	8	
Total	44	12	4	60	

US descriptors, and based on BI-RADS US assessment categories, the breast lesions in this study were classified into 5 BI-RADS US categories (from 1 to 5), where BI-RADS US category 1 represents negative findings, 2 represents benign lesions, while 3 stands for the probably benign ones, 4 is the suspicious malignant lesions and lastly 5 is for the highly suggested malignant lesions (7). Ultrasound category 2 was the most common category in this study representing 36.7%. This is conceded with Klein (17) who reported that the most common palpable breast masses are benign lesions. No breast lesions were categorized as 0 or 6 BIRADS US categories; where 0 represents the need for further imaging evaluation and 6 represents the known malignancy cases.

Histo-pathological examination of the biopsied specimen of each breast lesion was performed for the 56 patients. The most common benign breast lesion was fibroadenoma, as it was detected in 16 (26.7%) out of 60 patients, this was in accordance with Iglehart (21) who reported that fibroadenoma is the most common benign tumor of the breast and the most common breast tumor in women under age 30. Likewise it agrees with Klein (17) who stated that fibroadenoma is the commonest benign breast mass. The most common malignant breast lesions in this study were the invasive ductal carcinoma as it was detected in 8 (13.3%) out of 60 patients; this was in agreement with Masroor (22) and Disha (15) who reported that the incidence of invasive ductal carcinoma was 60% of the malignant breast lesions.

Correlation between the ultrasonographic and mammographic results with the pathological results for diagnosing breast lesions was performed. The diagnostic categories (Benign, indeterminate and malignant) of ultrasonography and mammography were statistically tested for their reliability for diagnosing and for differentiating between benign and malignant breast lesions using the pathological diagnosis as a gold standard. In this study ultrasonography had a diagnostic reliability for diagnosing and for differentiating between benign and malignant breast lesions in mammographically dense breasts ($p = 0.869$), where 44 cases were correctly diagnosed, only 4 cases were misdiagnosed and 8 cases were indeterminate. While mammography was diagnostically unreliable for detecting and diagnosing breast lesions ($p = 0.045$) where only 12 cases were correctly diagnosed, 40 cases were misdiagnosed and 4 cases were indeterminate.

A comparison between ultrasonographic and mammographic diagnostic reliability for the detection of breast lesions in mammographically dense breasts revealed that the ultrasound is far superior to the mammography in detection and characterization of breast lesions, this was statistically significant ($p = 0.035$). This is perfectly matches with Mujagić (23) who reported that ultrasound sensitivity for breast density categories 3 and 4 was significantly higher than the mammographic sensitivity ($p = 0.03$). Disha (15) also concluded in his study that the sensitivity of ultrasound was significantly higher than that of mammography in dense breasts (women younger than 45 years old) where p value < 0.01.

5. Conclusion

Assessment of breast lesions with the use of the BI-RADS US lexicon shows a significant diagnostic reliability for description and differentiation between benign and malignant breast lesions in ACR category 3 and 4 mammographically dense breasts.

Conflict of interest

None declared.

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